

Appendix B
cPAH Data and RAL Exceedance Areas
Relative to 2014 ROD RALs

1 Introduction

As described in the main text of this data evaluation report (DER) for the upper reach of the Lower Duwamish Waterway (LDW), remedial action level (RAL) exceedance areas were developed by comparing data in the design dataset with RALs, as defined in the US Environmental Protection Agency's (EPA's) November 2014 LDW Record of Decision (ROD) (EPA 2014) for all contaminants of concern except carcinogenic polycyclic aromatic hydrocarbons (cPAHs). RAL exceedance areas for cPAHs are based on RALs presented in the LDW Explanation of Significant Differences (ESD) (EPA 2021). The ESD for cPAHs was prepared by EPA to re-calculate the cPAH RALs, cleanup levels, and target tissue levels to reflect the latest scientific understanding of cPAH toxicity. The ESD provides the RALs that require remedial action in the LDW for cPAHs.

The purpose of this appendix is to evaluate the implications of using the cPAH RALs in EPA's 2014 ROD, as compared with RAL exceedance areas (shown in Map 3-3) using the cPAH RALs per the EPA ESD. The Lower Duwamish Waterway Group (LDWVG) is voluntarily evaluating whether additional RAL exceedance areas would be identified using the 2014 ROD RALs for cPAHs. Both sets of RALs are presented in Table B-1. RALs for cPAHs are expressed as a toxic equivalent (TEQ) (i.e., a cPAH TEQ), which relates the toxicity of the seven cPAHs to that of benzo(a)pyrene.¹

Table B-1
cPAH RALs in the 2014 ROD and 2021 ESD

RAL Category	Depth Interval	cPAH TEQ RALs ($\mu\text{g}/\text{kg dw}$)	
		ROD (EPA 2014), Table 28	ESD (EPA 2021), Table 3
Intertidal Sediments			
Recovery Category 1	Top 10 cm (4 in.)	1,000	5,500
	Top 45 cm (1.5 ft)	900	5,900
Recovery Categories 2 and 3	Top 10 cm (4 in.)	1,000	5,500
	Top 45 cm (1.5 ft)	900	5,900
Subtidal Sediments			
Recovery Category 1	Top 10 cm (4 in.)	1,000	5,500
	Top 60 cm (2 ft)	1,000	5,500
Recovery Categories 2 and 3	Top 10 cm (4 in.)	1,000	5,500
	Top 60 cm (2 ft.)	-	-
Shoaled Areas in FNC	Top to authorized nav. depth plus 2 ft	1,000	5,500

¹ The seven cPAHs included in the cPAH TEQ are benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. cPAH TEQs may also be referred to as benzo(a)pyrene equivalents, as was done in EPA's ESD (EPA 2021).

Notes:

cPAH: carcinogenic polycyclic aromatic hydrocarbon
 dw: dry weight
 ESD: explanation of significant differences
 FNC: Federal Navigation Channel
 RAL: remedial action level
 ROD: Record of Decision

This appendix presents the following:

- A comparison of all cPAH results in the design dataset
- An evaluation of the effect of RAL selection on RAL exceedance areas
- An assessment of preliminary technology options for cPAH-only areas identified using 2014 ROD RALs
- A discussion of potential Phase III data gaps

2 Additional Phase II samples analyzed for cPAHs

In addition to chemical analyses conducted per the Pre-Design Investigation (PDI) Quality Assurance Project Plan (QAPP) (Windward and Anchor QEA 2020) and Addendum to the PDI QAPP for Phase II (Phase II QAPP Addendum) (Anchor QEA and Windward 2021), cPAHs were analyzed in 14 additional samples. This occurred because the cPAH TEQs at or near these locations in pre-PDI or PDI samples were less than the ESD RAL but greater than the 2014 ROD RALs. These 14 samples were from 6 locations (677, 678, 681, 683, 684, and 703X) (Map B-1). cPAH TEQs for all 14 of these samples were less than both the ROD and ESD RALs (Table B-2).

Table B-2
Additional Phase II samples analyzed for cPAHs

Area	Phase II Sample				Rationale for Analysis
	Location Number	Sample ID	Interval (cm)	cPAH TEQ (µg/kg dw)	
Slip 6; RM 4.2	677	SC677	0–60	137	Re-occupying LDW-SC53 (2006), which had a TEQ of 1,200 J µg/kg dw and a ROD RAL cPAH EF of 1.2 (0–60 cm)
	678	SS678	0–10	93.1	Re-occupying R-41 (1997), which had a TEQ of 1,200 µg/kg dw and a ROD RAL cPAH EF of 1.2 (0–10 cm)

Area	Phase II Sample				Rationale for Analysis	
	Location Number	Sample ID	Interval (cm)	cPAH TEQ (µg/kg dw)		
Turning Basin; RM 4.6 East	681	IT681	0–45	63.4	Bounding subsurface to north of PDI location 379; note that SS681 had a cPAH TEQ of 94.4 µg/kg dw (0–10 cm)	
	683	IT683B	45–75	20.8 J	Providing vertical extent information for remedy design in this area	
		IT683C	75–105	9.86 J		
		IT683D	105–135	5.57 J		
		IT683E	135–165	4.54 J		
		IT683F	165–213	4.54 J		
	684	IT684B	45–75	26.0 J	Providing vertical extent information for remedy design in this area	
		IT684C	75–105	8.82 J		
		IT684D	105–135	14.9 J		
		IT684E	135–165	4.98 J		
		IT684F	165–210	4.45 J		
	Norfolk; RM 4.9	703X	IT703X	0–45	79.3	Evaluating cPAH TEQ near NFK207 (1995), which had a cPAH TEQ of 1,500 J µg/kg dw in a non-RAL interval sample (0–61 cm) near this location

Notes:
 cPAH: carcinogenic polycyclic aromatic hydrocarbon
 dw: dry weight
 EF: exceedance factor
 ID: identification
 J: estimated concentration
 PDI: Pre-Design Investigation
 RAL: remedial action level
 RM: river mile
 ROD: Record of Decision
 TEQ: toxic equivalent

3 Comparison of cPAHs with ROD RALs and ESD RALs

Like Section 3 of the DER, this section presents a comparison of the design dataset for the upper reach with both the 2014 ROD RALs and ESD RALs for cPAHs (Table B-3). A total of 11 locations (9 surface sediment, 1 intertidal subsurface sediment, and 1 shoaling core) had exceedances of the 2014 ROD RAL for cPAHs. Only one surface sediment sample had a cPAH TEQ exceeding the ESD RAL. Details regarding the 11 locations with cPAH TEQs greater than the 2014 ROD RAL are presented in Table B-4, and these locations are shown on Map B-2 (surface sediment) and Map B-3 (subsurface sediment).

Table B-3
Summary of cPAH RAL Exceedances in the Design Dataset

Interval	Comparison with 2014 cPAH ROD RALs		Comparison with cPAH ESD RALs	
	No. > RAL/Total	%	No. > RAL/Total	%
Surface (0–10 cm)	9/495	2	1/495	0.2
Subsurface (0–45 cm)	1/61	2	0/61	0
Subsurface (0–60 cm)	0/36	0	0/36	0
Shoal intervals (depth varies) ¹	1/36	3	0/36	0

Notes:

1. Shoal interval samples consisted of shoaled material in the FNC (i.e., sediment above -15 ft MLLW in this reach of the LDW) and sediment from the -15 to -17-ft interval.

cPAH: carcinogenic polycyclic aromatic hydrocarbon

ESD: explanation of significant differences

FNC: Federal Navigation Channel

LDW: Lower Duwamish Waterway

MLLW: mean lower low water

RAL: remedial action level

ROD: Record of Decision

Table B-4
Details Regarding Samples with cPAH ROD RAL Exceedances

Location Name	RAL Category	Year	cPAH TEQ (ug/kg dw)	2014 ROD RAL EF	ESD RAL EF	River Mile	Other RAL Exceedances
LDW20-SC148	Subtidal (shoal)	2020	1,100 J	1.1	0.20	3.3	mercury, fluoranthene
LDW-SS112	Surface (0–10 cm)	2005	1,500	1.5	0.27	3.7 E	PCBs, arsenic, BBP
LDW-SS114	Surface (0–10 cm)	2005	1,800 J	1.8	0.33	3.8 E	PCBs, arsenic
SD-506G	Surface (0–10 cm)	2012	1,700	1.7	0.31	3.8 E	PCBs, arsenic
R22	Surface (0–10 cm)	1997	3,500	3.5	0.64	3.8 E	PCBs, arsenic, other PAHs
LDW-SC51	Surface (0–10 cm)	2006	2,200	2.2	0.40	3.8 E	none
R23	Surface (0–10 cm)	1997	6,600	6.6	1.2	3.8 E	PCBs, BBP, PAHs; also exceeds cPAH ESD RAL
LDW-SS157	Surface (0–10 cm)	2005	1,900	1.9	0.35	3.8 E	none
LDW20-IT379	Intertidal (0–45 cm)	2020	2,080 J	2.1	0.35	4.6 E	other PAHs
LDW20-SS379	Surface (0–10 cm)	2020	2,630	2.6	0.48	4.6 E	other PAHs
LDW20-SS384	Surface (0–10 cm)	2020	1,980 J	2.0	0.36	4.7 W	none

Notes:

BBP: butyl benzyl phthalate

cPAH: carcinogenic polycyclic aromatic hydrocarbon

dw: dry weight

EF: exceedance factor

ESD: explanation of significant differences

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl
RAL: remedial action level
ROD: Record of Decision
TEQ: toxic equivalent

Of the 11 locations with cPAH ROD RAL exceedances, 8 also have exceedances for other contaminants and are within existing RAL exceedance areas. Of the other three locations (all surface sediment samples), two are located adjacent to Area 18 (river mile [RM] 3.8 East), and one is located in the Turning Basin (RM 4.7 West). Prior to the Phase II PDI sampling, there were samples from two locations in Slip 6 with cPAH TEQs greater than the ROD RAL. These locations were reoccupied during Phase II PDI sampling, at which time TEQs were less than the ROD RAL (Table B-2).

Map B-4 shows where RAL exceedance areas would change with the use of the 2014 ROD RAL for cPAHs (no other contaminants exceed RALs). Specifically, the map incorporates Thiessen polygons for cPAH-only exceedances of the 2014 ROD RAL; the additional areas are shown as orange polygons on Map B-4. These changes, both of which are based on surface sediment exceedances, include a small size increase of Area 18 (RM 3.8 East) and a new area in the Turning Basin (RM 4.7 West).

4 Preliminary Remedial Technology Assignments

As described in the DER, the 2014 ROD presents flow charts used to identify remedial technologies that may be applicable in RAL exceedance areas. Preliminary technology options for the two areas identified using the 2014 ROD RAL for cPAHs are as follows:

- Expanded portion of Area 18 (RM 3.8 East) – As with the other intertidal portions of Area 18, dredge and backfill or partial dredge and cap are applicable remedial technologies, as is area-specific technology because there is a structure adjacent to this area.
- New area in Turning Basin (RM 4.7 West) – There are no structural or access limitations, the area is not in Recovery Category 1, and the cPAH concentrations are less than the enhanced natural recovery (ENR) upper limit (ROD Table 28). Therefore, ENR is applicable for this area.

Engineering considerations evaluated during 30% and 60% remedial design (RD) and additional data collected during the Phase III PDI will be used to select final remedial technologies for these two areas.

5 Initial Identification of Phase III Data Gaps

This section identifies data gaps that may be filled in the Phase III PDI to address data needed for RD related to the additional RAL exceedance areas based on only the cPAH 2014 ROD RAL (Table B-5). As described in the DER, additional data gaps will be identified during 30% design and design review.

**Table B-5
Evaluation of Data Gaps for cPAH 2014 ROD RAL areas**

DQO	Evaluation of Phase III Data Gaps
Further horizontal delineation (DQOs 9 and 10)	cPAHs are bounded horizontally in areas with 2014 ROD RAL exceedances. A final analysis will be conducted in the Phase III QAPP Addendum following 30% design.
Further vertical delineation (DQO 12)	cPAH exceedances relative to the 2014 ROD RAL are limited to surface sediment or are already bounded vertically (Area 29), with the exception of additional vertical data needed in Area 11 to bound exceedances for mercury, fluoranthene, and cPAHs in the shoaled material. These data are needed regardless of the cPAH RAL selected, although the depth may vary for the various contaminants.
Other engineering data (DQO 14)	<p>The potential need for additional engineering data was considered for the two areas:</p> <ul style="list-style-type: none"> • Expanded portion of Area 18 (RM 3.8 E) – No additional engineering data are needed; existing PDI data are sufficient for RD. • New area in Turning Basin (RM 4.7 E) – Topographic survey data are needed for this area. Other existing PDI engineering data (e.g., geotechnical data) are sufficient for RD.

Notes:

cPAH: carcinogenic polycyclic aromatic hydrocarbon

DQO: data quality objective

PDI: Pre-Design Investigation

QAPP: Quality assurance Project Plan

RAL: remedial action level

RD: remedial design

ROD: Record of Decision

RM: river mile

5 References

- Anchor QEA, Woodward. 2021. Quality assurance project plan addendum for the Lower Duwamish Waterway Upper Reach: Pre-Design Investigation Phase II. Final. Submitted to EPA June 25, 2021. Anchor QEA and Woodward Environmental LLC, Seattle, WA.
- EPA. 2014. Record of Decision. Lower Duwamish Waterway Superfund Site. US Environmental Protection Agency.
- EPA. 2021. Proposed explanation of significant differences. Draft for public comment. Lower Duwamish Waterway Superfund site. US Environmental Protection Agency Region 10, Seattle, WA.
- Woodward, Anchor QEA. 2020. Lower Duwamish Waterway quality assurance project plan for remedial design of Upper Reach: pre-design investigation. Final. Submitted to EPA May 19, 2020. Woodward Environmental LLC and Anchor QEA, Seattle, WA.